



# TS-NH

THERMOSALINOGRAPH

## Technical Manual



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# Revision History

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## February 2017

- Updated cleaning procedure.
- Added a recommended maintenance list to the maintenance chapter.
- Updated TRDI website address to <http://www.teledynemarine.com/rdi>

## April 2016

- Updated the CAOP, RAOP, SAOP commands
- Added #N command
- Updated the SFRM and ADR commands

## June 2014

- Corrected how to request a Return Material Authorization (RMA)
- Updated fonts and styles

## March 2012

- Added Cleaning the TS-NH Sensor, Main External Components, and TS-NH Options sections.
- Added 96F-6014 Hose Coupling outline installation drawing.
- Changed “PSU-78” to “The seawater salinity in accordance to PSS78 (Practical Salinity Scale 1978)”.

## February 2010

- Converted manual to TRDI format.

## **NOTES**



## TS-NH Technical Manual

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### Introduction

This manual covers the operational aspects of the Teledyne RD Instruments (TRDI) TS-NH sensor. Your TS-NH sensor is designed to collect high precision salinity data. The basic instrument measures conductivity using a high stability inductive conductivity sensor which is calibrated over the oceanographic range of 0 - 70 mmho/cm (0 - 7 S/m). Temperature is measured with a thermistor thermometer mounted in close proximity.

When power is applied to the TS-NH sensor, the sensor goes to run mode. In run mode the sensor will output data in engineering or scaled units. See section "Data Output Format" for a complete description on the output data format from the run mode data message.

Data is transmitted in scaled or calibrated ASCII physical units. The sensor outputs Conductivity, Temperature, Salinity, and Sound Velocity in ASCII physical units. The Command/Data Serial Port supports either RS-232C, RS-485 or TTL levels of communication.

Instrument operation is performed using simple single character ASCII commands given to the instrument via the Command/Control port. A computer using any terminal emulation program may be used to interact with the instrument, see the command section for specific commands and responses.

## Customer Service

TRDI welcomes your feedback. Please contact TRDI customer service to offer any comments or suggestions or to request technical support. TRDI can be contacted using any of the following means:

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### Self-Service Customer Portal

Use our online customer portal at <http://www.teledynemarine.com/rdi> and click on the **Support** link to download manuals, firmware updates, software, or other Teledyne RDI documentation. Log into your account and then click the **Software/Firmware** link or **Documentation** link.

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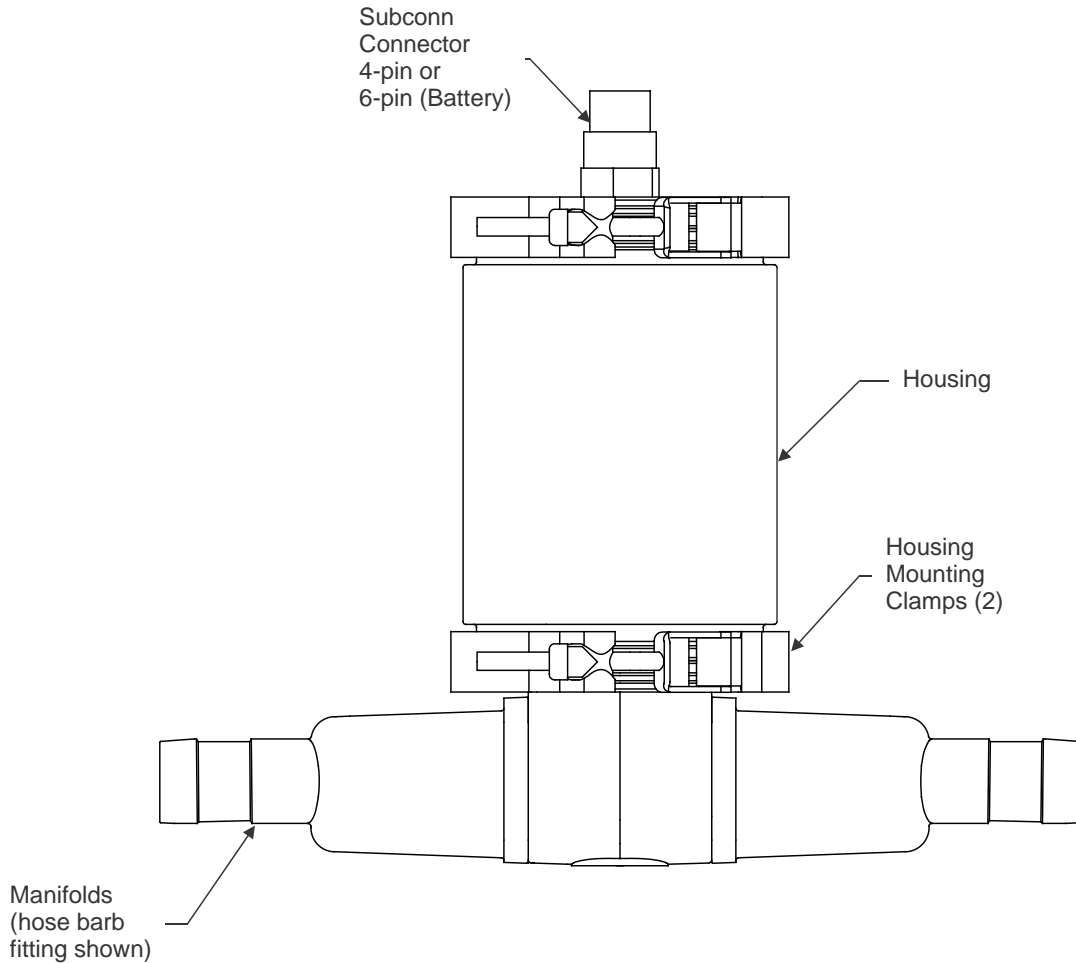
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## Main External Components

The main external components of the TS-NH are shown in Figure 1. The conductivity and temperature sensors are located on the top end cap. The conductivity sensor is free flushing with no exposed electrodes that can foul or external fields that can affect calibration. The temperature sensor is aged and therefore highly stable and is directly in the water flow path of the conductivity sensor.

A single 4-pin (Direct Reading units) or 6-pin (Battery or External Sensor Interface units) bulk-head connector on the lower end cap provides RS-232, RS-485 or CMOS TTL level digital communications and inputs external power.



**Figure 1. The Location of the TS-NH Main External Components**

# TS-NH Options


**Depth Rating** – TS-NH units are available with the following depth rating: 500 meter (Delrin housing), 2000 meter (Aluminum housing), or 7000 meter (Titanium housing).

**Hardware Interface** – The manifolds are available with standard hose bib threads, Whitworth thread, or barb fittings.

**Communications Port** – The bulk head connector can be configured for the following communications: RS-232, RS-485, or CMOS.

**External Sensor Interface** – The Option 1 and Option 2 connectors are used to connect to optional external sensors.

**Battery Pack** – An internal alkaline battery pack is used to power the TS-NH when the instrument is deployed autonomously. The battery pack comprises 16 welded alkaline "C" size cells.



**NOTE.** TS-NH options must be defined at time of order.

TS-NH part numbers use a seven field code - 111-22-3-444444-5555-6666-7.

Field 1	Field 2	Field 3	Field 4					Field 5	Field 6	Field 7	
Family - Thermosalinograph	Inductive Technology Type NH = NXIC Horizontal	External Sensor Interface	Bit 1 = DR (No Battery) / SC (Battery)	Bit 2 = Board Electronics Type	Bit 3 = Hardware Interface Type	Bit 4 = Communications Type	Bit 5 = Housing Depth Rating (meters)	Bit 6 = Stem Length	Field 5 = Depth Rating of Conductivity (meters)	Field 6 = Press Sensor Option (meters)	Field 7 = OEM Temperature Probe Mounting Position
TS	NH	0 = None 1 = Yes	0 = DR B = SC	0 = NXIC	0 = N/A 1 = Hose bib 2 = Whitworth thread 3 = Barb	0 = CMOS (TTL) 1 = RS232 2 = RS485	0 = None 1 = 500 2 = 2000 3 = 7000	0 = N/A	0 = No Cond 500 7000	0 = N/A	0 = N/A

Example: TS-NH-0-001110-500-0-0 corresponds to a Thermosalinograph, NXIC Horizontal, DR, Hose bib, RS232.

# System Overview

## Electrical Interface

Once a general understanding of the command structure has been achieved, the user can verify correct TS-NH operation. Data can be verified for correct operation, near zero conductivity and near room temperature

## Communication Protocols

The TS-NH is provided with RS-232, RS-485 or TTL data interface, which should be selected by the customer at time of order. Use of the RS-232 port requires that your computer supply true RS-232 data levels. The communication protocol is 9600, no parity, 8 data bits and 1 stop bit.

**Table 1: Connector Manufacturer**

TYPE	MFG. PART NUMBER	TRDI PART NUMBER
BULKHEAD	MCBH4F	2106-MCBH4F
PIGTAIL	MCIL4M	2106-MCIL4M
DUMMY PLUG	MCDC4M	2106-MCDC4M
TEST CABLE	N/A	C176-099



**NOTE.** Consult the table below or the SUB CONN manual for color code of the wires in the connecting pigtail. Pigtails and custom cables are available directly from TRDI.

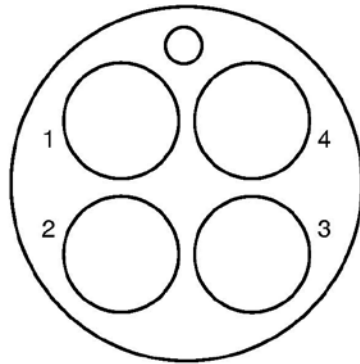
**Table 2: Pigtail Color Codes/Functions**

PIN	COLOR	RS-232	RS-485	TTL
1	BLACK	GROUND	GROUND	GROUND
2	WHITE	RXD	RS-485A	RXD
3	RED	+ POWER	+POWER	+POWER
4	GREEN	TXD	RS-485B	TXD

**Table 3: Test Cable Pin Out**

CONNECTOR	PIN	RS-232	RS-485
DB-9	2	RXD	RS-485A
DB-9	3	TXD	RS-485B
DB-9	5	DATA GROUND	DATA GROUND
POWER JACK	Internal	+ POWER	+POWER
POWER JACK	External	GROUND	GROUND

## Bulkhead Connector Detail



**Figure 2. 4-pin Bulkhead Connector Face View**

**Table 4: TS-NH Bulkhead 4-pin Connector to Computer Connections**

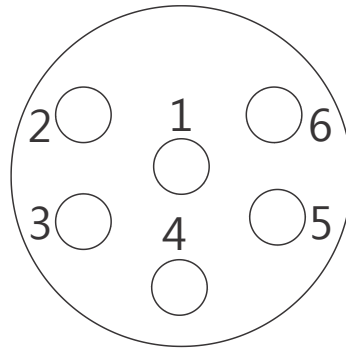
PIN	LABEL	FUNCTION
1	GND	Ground
2	RXD/RS-485A	Received Data from Computer
4	TXD/RS-485B	Transmitted Data to Computer

**Table 5: TS-NH Bulkhead 4-pin Connector to Power Supply Connections**

PIN	LABEL	FUNCTION
1	GND	Ground
3	Power(+)	Instrument Power



**NOTE.** The 4-pin connector is used on Direct Reading TS-NH units only.



**Figure 3. 6-Pin Bulkhead Connector Face View**

**Table 6: TS-NH 6-pin Bulkhead Connector to Computer Connections**

PIN	LABEL	FUNCTION
1	GND	Ground
2	RXD/RS-485A	Received Data from Computer
4	TXD/RS-485B	Transmitted Data to Computer
5	BAT SWITCH	Battery Switch
6	BAT SWITCH	Battery Switch

**Table 7: TS-NH 6-pin Bulkhead Connector to Power Connections**

PIN	LABEL	FUNCTION
1	GND	Ground
3	Power(+)	Instrument Power



**NOTE.** The original 4-pin bulkhead connector is replaced with a 6-pin bulkhead connector when the TS-NH includes the External Sensor Interface, battery, or the End Cap Switch Kit. The optional End Cap Switch Kit gives the user the ability to easily connect and disconnect the internal battery.

## External Power

The TS-NH should be powered from a constant voltage power supply. The power supplied to the instrument should maintain a minimum compliance voltage of 8 - 35 volts DC. The standard instrument consumes 25 milliamps of current on average.



**CAUTION.** Do not input voltages greater than 35 VDC or damage to the TS-NH may occur.

# Outline Installation Drawing

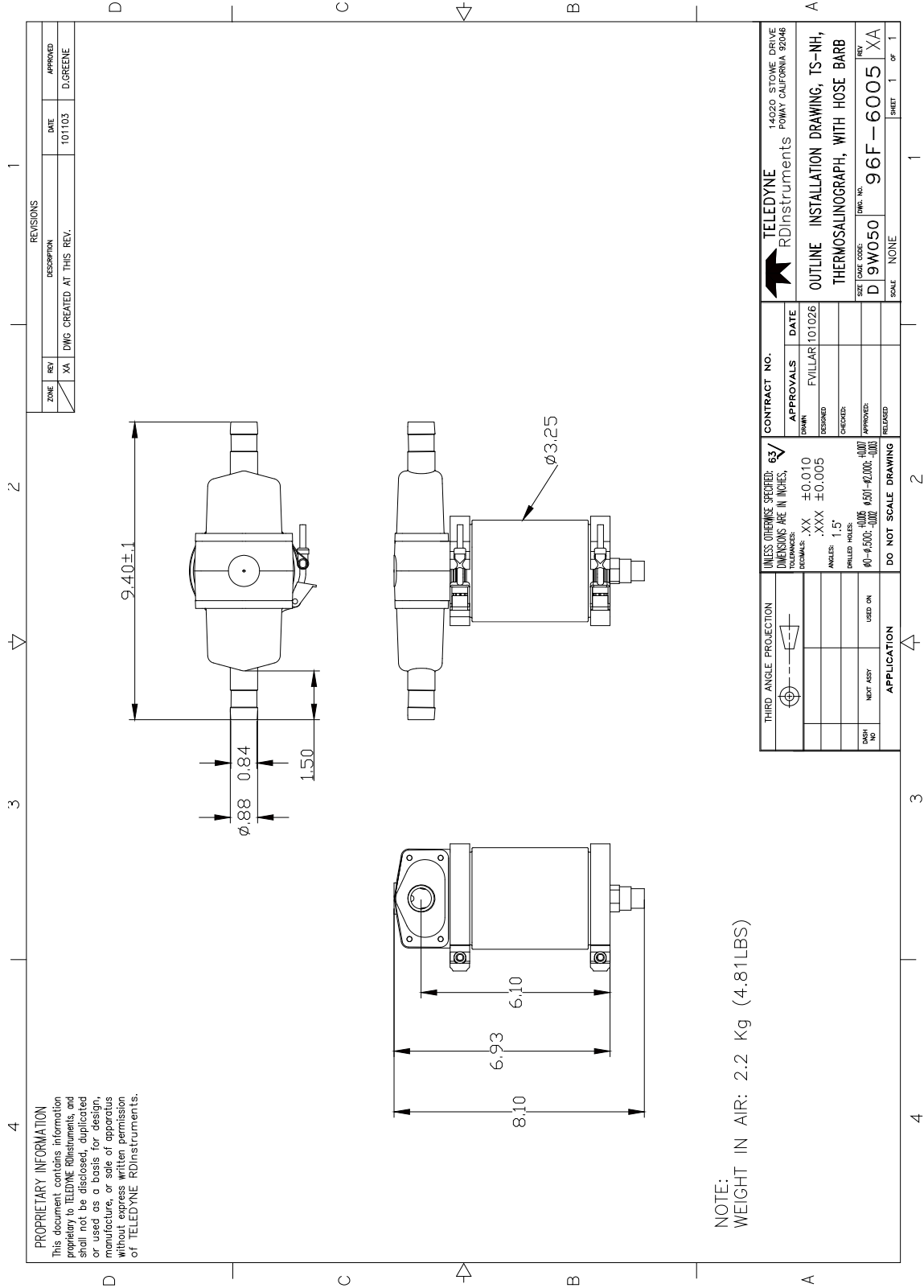


Figure 4. TS-NH with Hose Barb Outline Installation Drawing

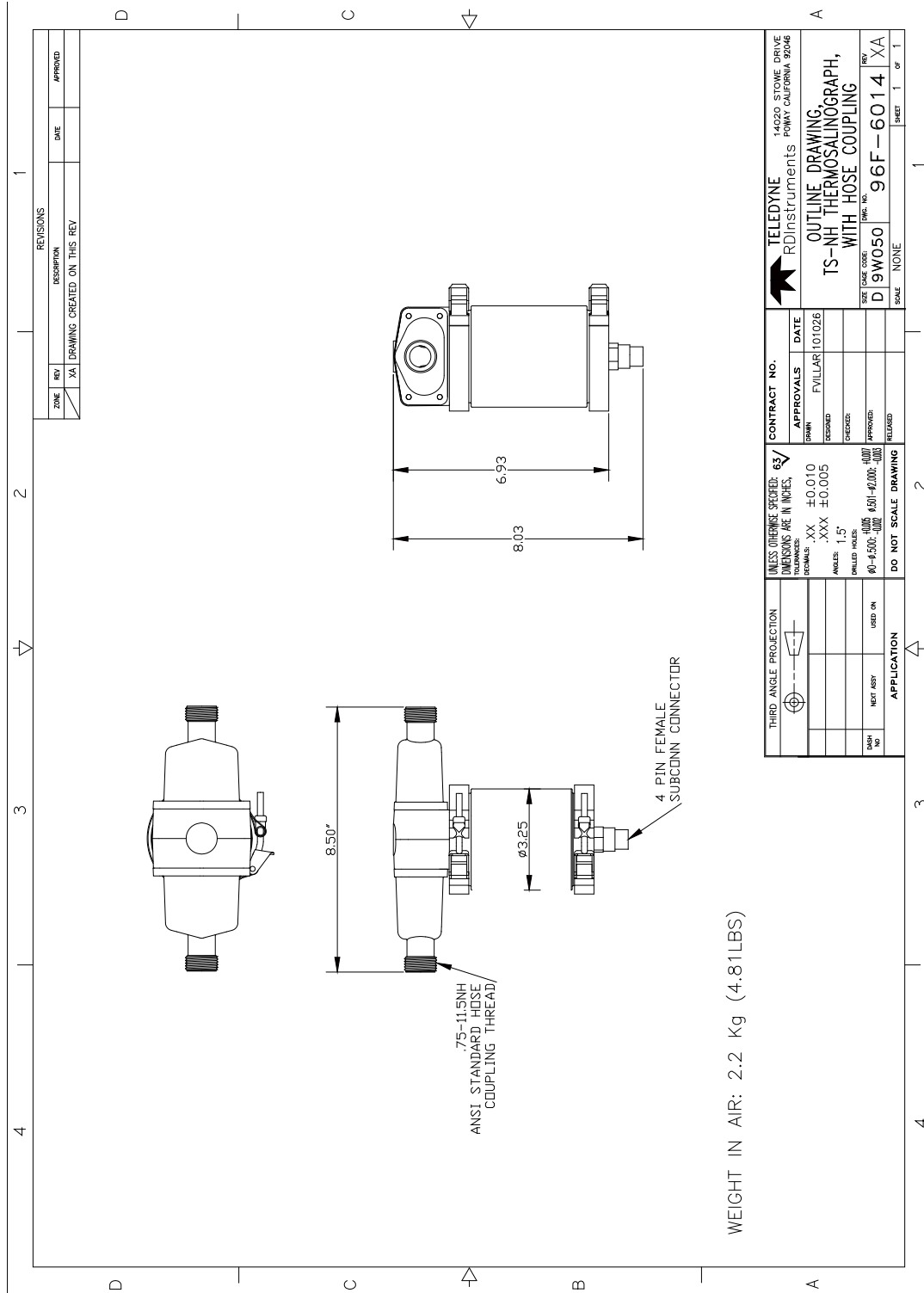


Figure 5. TS-NH with Hose Coupling Outline Installation Drawing



**NOTE.** Available with standard hose coupling thread or Whitworth thread; Dimensions are the same.

## Modes of Operation

The TS-NH operates in one of three modes; **RUN** mode, **CAL** mode, or **OPEN** mode. These operational states are depicted in the "state" diagram on the following pages. The TS-NH user must fully understand the relevance of each of these operational modes to become a proficient user of the instrument. The TS-NH has a high level of user interface, which allows the user to easily move from one mode to another.

### Run Mode (Normal)

RUN mode is the normal data collection-operating mode. The TS-NH always powers up in the RUN mode (if calibration parameters are incorrect or missing, the unit will use default operational and calibration parameters and continue to power up in the RUN mode). RUN mode is entered from OPEN mode using the '\*\*\*R' command.

### Sampling Rate

The sample rate is defined as the number of scans per second, where a "scan" is defined as a complete set of CT data. The TS-NH has an adjustable sampling rate. The sampling rate range is from 1 to 5 scans/sec and is changed by the SRATE command.

### Open Mode

OPEN mode is used to update calibration and other operational parameters. While the instrument is in the OPEN mode all data collection functions are stopped. In this mode the user can access all instrument configurations such as calibration constants and parameter output/stored selections. All data requests in the OPEN mode will be responded to with an "OPEN MODE" response.

### CAL Mode



**NOTE.** The calibration mode is used by the factory to calibrate the instrument and is typically not used by the customer unless the user needs the data for diagnostic requirements.

The CAL mode provides functions used during calibration. While the instrument is operating in the calibration mode, data processing is stopped and raw data counts are output to the user, allowing calibration coefficients to be determined. This mode is usually used only by the factory or for user diagnostic purposes.

While the instrument is operating in the "Calibration Mode", "raw data" is available for C and T references (SEE Section Operational modes for the TS-NH Operational State Diagram that shows the various TS-NH operating modes). The "raw" data types are used by the factory to calibrate the TS-NH. Within the calibration mode, the instrument reports 2 distinct data sets, one for each reference setting for the C and T sensor outputs. When in this mode and data is requested using either the <CR> or <LF> command.



# Data Output

## Engineering Data Format

(SCALE=OFF)

When SCALE is OFF the TS-NH will output TSG data and engineering units. When powered and operating in normal RUN mode operation, the message is:

CCC.CCC, TTT.TTT, SS.SSS, VVVV.VVV<CR><LF>

**Table 8: TS-NH Data Message - (SCALE=OFF)**

Name	Format	Range	Units
Conductivity	CCC.CCC	0 – 90	mmho/cm
Temperature	TTT.TTT	-3 – 45	°Celsius (ITS-90)
Salinity	SS.SSS	2-42	The seawater salinity in accordance to PSS78 (Practical Salinity Scale 1978)
Sound Speed	VVVV.VVV	1450-1550	m/s



**NOTE.** Salinity and sound velocity values are calculated values. To enable these channels, use the SSV command in OPEN MODE.

## Scaled Run Mode Data Format

(SCALE=ON)

The TS-NH continuously outputs messages during data collection. When powered and operating in normal RUN mode operation, the message is:

CCCCCCC,TTTTTTT,SSSSSSS,VVVVVVV<CR><LF>

**Table 9: TS-NH Data Message - (SCALE=ON)**

Name	Format	Range	Internal Scaling
Conductivity	CCCCCCC	0 – 16777216	(C(mmho/cm) + 2) * 200000
Temperature	TTTTTTT	0 – 16777216	(T(ITS-90) + 2.5) * 400000
Salinity	SSSSSSS	0 – 16777216	(S(PSS78) + 2) * 200000
Sound Velocity	VVVVVVV	0 – 16777216	(SV(m/s)-1450) * 16000

**Format Notes:** C, T, P = INTEGER 0 - 9  
 , = COMMA HEX(2C)

To convert a data channel to engineering units us the following equations:

**Table 10: Converting TS-NH Scaled Data**

Name	Engineering Units Conversion	Units
Conductivity	$(C_{scaled}/200000) - 2$	mmho/cm
Temperature	$(Temperature/400000) - 2.5$	°C (ITS-90)
Salinity	$(S_{scaled}/200000) - 2$	The seawater salinity in accordance to PSS78 (Practical Salinity Scale 1978)
Sound Velocity	$(V_{scaled}/16000) + 1450$	M/s

# TS-NH Maintenance

To ensure your TS-NH continues to provide you with accurate data, you should inspect and clean the instrument after each use. This section provides some inspection and cleaning recommendations and instructions on how to replace the battery pack.

## Recommended Maintenance

**Table 11. Recommended Maintenance**

<b>User Maintenance</b>	
<b>Item</b>	<b>TRDI Recommended Period</b>
Housings/End Caps	Inspect for damage and replace as required.
Hardware (bolts, nuts, washers, etc.)	Manufacturer recommends replacement after every deployment or every at least each year. Damaged hardware should never be used.
O-rings	Manufacturer recommends replacement every time the instrument is opened. Damaged O-rings should never be used.
Connector	Inspect for damage and replace as required. Damaged connectors should never be used.
Conductivity Sensor	Manufacturer recommends verification of reasonable performance before each deployment; i.e. a reference comparison.
Temperature	Manufacturer recommends verification of reasonable performance before each deployment; i.e. a reference comparison.
<b>Calibration*</b>	
<b>Item</b>	<b>TRDI Recommended Period</b>
Conductivity Sensor	Manufacturer recommends return every 1 to 2 years for Factory calibration.
Temperature Sensor	Manufacturer recommends return every 1 to 2 years for Factory calibration.
<p>*The measurement error band of the CTD will widen over time due to component aging. This effect happens regardless of whether or not the instrument is being operated. Due to the stringent accuracy specifications, the effects of drift rapidly become a significant portion of the overall instrument error budget. For example, the error band for the conductivity measurement will reach twice its initial value three months after calibration. Periodic recalibration of the instrument is recommended to return to the original error band.</p>	

Factory Maintenance	
Item	TRDI Recommended Period
Housing/End Caps	3 to 5 years maximum: return to manufacturer for inspection, shorter periods may be required depending on marine growth.
O-rings	3 to 5 years maximum: return to manufacturer for replacement.
Connector	3 to 5 years maximum: return to manufacturer for replacement.

## Cleaning and Inspecting the TS-NH

To remove foreign matter and biofouling:

1. Remove soft-bodied marine growth or foreign matter with soapy water. Waterless hand cleaners remove most petroleum-based fouling. If there is heavy fouling or marine growth, TRDI recommends soaking the affected areas in a 50:50 bath of fresh water and apple cider vinegar for one to two hours to break down the shell-like parts. Use a wooden dowel to carefully break up larger pieces of the shells. Scrubbing with a medium stiffness brush usually removes the remaining soft-bodied parts.



Do NOT use power scrubbers, abrasive cleansers, scouring pads, high-pressure marine cleaning systems or brushes stiffer than hand cleaning brushes as this can scratch surfaces and damage softer parts like urethanes and sealants used in the construction of the system.

Do NOT use excessive force when breaking up larger pieces of shells or you risk damaging the sensitive components on the external or inside of the system.

2. Rinse with fresh water to remove soap or apple cider vinegar residue.
3. Repeat steps 1 – 3, as required to remove heavy marine growth.



Do NOT soak for longer than two hours at any time and always rinse with fresh water between soakings. Soaking for longer than two hours at a time can break down the urethane and other sealants used in the construction of the system.

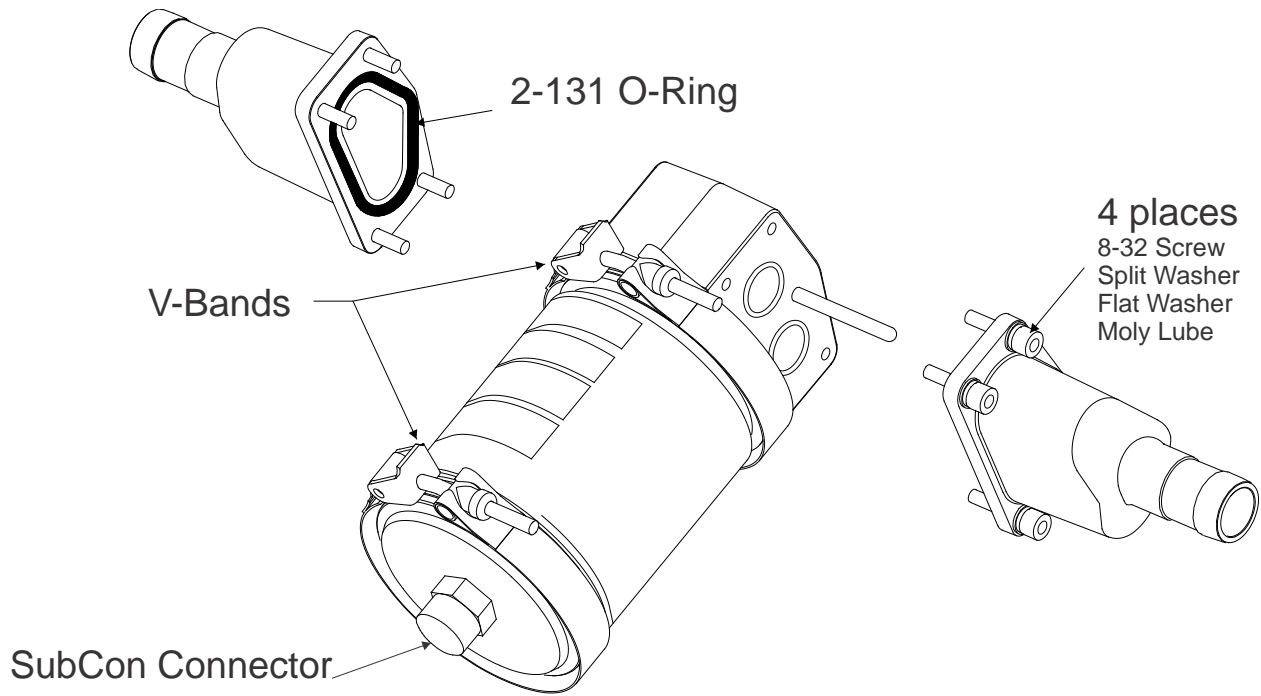
4. Dry the system with low-pressure compressed air or soft lint-free towels.



Do NOT use high pressure or you may damage softer surfaces.

Always dry the system before placing it in the storage case to avoid fungus or mold growth.

After cleaning the instrument, check it carefully for signs of damage. Check the bulkhead connector for looseness or other signs of damage. Check the pins of the bulkhead connector. They should be kept clean at all times. Clean the connector pins and sockets with an alcohol wipe, and when reconnecting, lubricate the rubber portion of the pins with an O-ring quality silicone based lubricant. After cleaning the instrument, check it carefully for signs of damage. Check the bulkhead connector for looseness or other signs of damage. Check the pins of the SubCon bulkhead connector. They should be kept clean at all times. Clean the connector pins and sockets with an alcohol wipe, and when reconnecting, lubricate the pins with an O-ring quality silicone or barium based lubricant. If one or more optional sensors are installed, the end cap includes, in addition to the 6-pin bulkhead connector, an Options 1 and Options 2 connector.



**Figure 6. Cleaning the TS-NH Sensor Head**

# Commands

## Command Details

### Command Section Nomenclature



**NOTE.** All of the following commands are given to the instrument via the command port. Data from the instrument is only transmitted or stored while the instrument is in the "run" operational mode. A request for data while the instrument is operating in the "open mode" will result in the response "open mode" from the TS-NH.

Each Command that the TS-NH responds to have a "Description" on the following pages. The commands are listed in alphabetical order. Each of the "Descriptions" has been written the following format: The command appears at the top of the page. Below the command, Usage shows the exact syntax of the command. Mode indicates the operating mode the TS-NH must be in to respond to the command. Description outlines the command's effects. Return describes what, if anything, the command returns. See also references related commands. Example provides more information on the command, its use, and implications. It is formatted as: Line 1: command sent, Line 2: characters received.

### Command Format Notes

- A terminating character must be received before entry processing starts.
- Commands may be terminated with either a LINE FEED (0Ah) or CARRIAGE RETURN (0Dh) character, or both.
- Responses from the TS-NH are terminated with both CARRIAGE RETURN and LINE FEED characters.
- All characters received after the first terminating character is ignored until processing the entry is completed.
- Except where noted, command characters can be either UPPER or lower case.
- For any invalid command, the TS-NH will respond with "BAD COMMAND" and the "bell" character and may or may not give an error message depicting the nature of the error. A command is invalid if it is not recognized or if it is incomplete or parts are incorrect. Also where noted, some commands are only valid when the TS-NH is in a specific mode and invalid in the other modes.
- The commands, as detailed in this section, relate only to the version of firmware as listed on the front of this manual. Your instrument may have additional or fewer commands than are listed herein. If you have any questions related to either the firmware your instrument is equipped with and/or lack of command response, consult the factory.

## Operation Modes

The TS-NH operates in one of three modes; RUN mode, CAL mode or OPEN mode. The CAL mode provides functions used during calibration. OPEN mode is used to update calibration and other operational parameters. RUN is the normal operating modes from which physical data is obtained from the device. The unit always powers up in the RUN mode (if calibration parameters are incorrect or missing the unit will power up in the OPEN mode). All data requested in the OPEN mode will be responded to with an "OPEN MODE" response.

In the Table on the following pages, all commands and the mode under which they operate are listed (Note: some commands are listed under two or more modes of operation). See detailed descriptions listed in the following sections of the manual for complete command operational usage and responses.

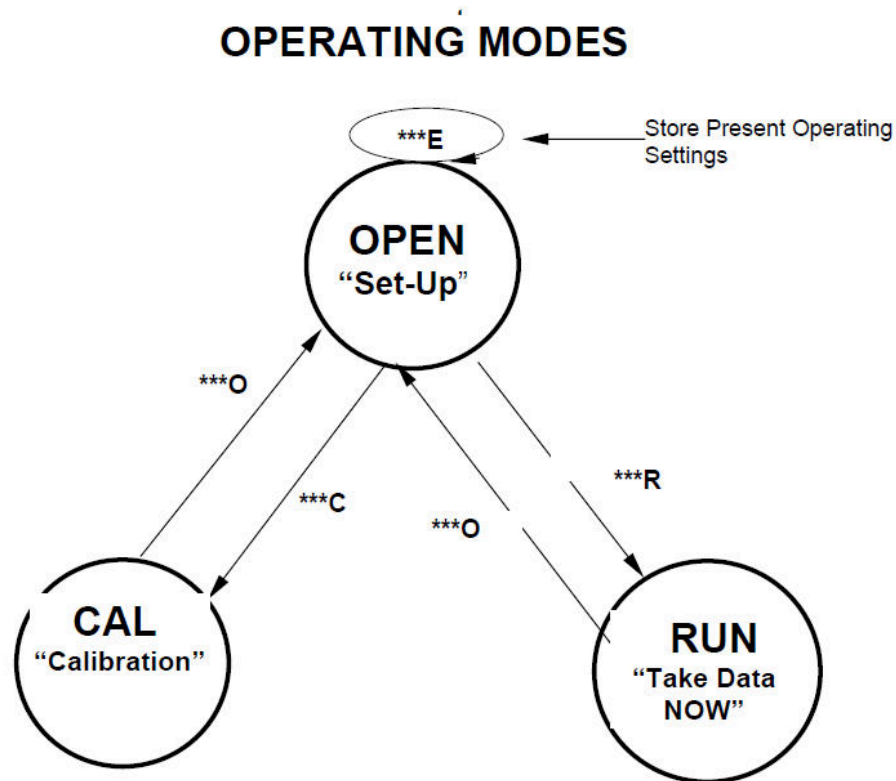


Figure 7. TS-NH State Diagram

**Table 12: Command Table**

Mode Run	Mode Open	Mode Cal	Description
RAW			Output Raw A/D Values
MODE	MODE		Reads Current Operating Mode
PI	PI		Sets The Pressure Constant (DBar)
C	C		Check TSG Status
SRATE	SRATE		Reads Or Sets The Scan Rate
***O		***O	Go to Open Mode
S		S	Stop Continuous Output Data Mode
SC		SC	Set Continuous Output Data Mode
	***C		Go to Calibration Mode
	***R		Go to Run Mode
	***E		Write Cal & Operation To EEPROM
	ADR		Set TS-NH Address Number
	CAOP		Clear Address Operation
	RAOP		Reads Address Operation
	SAOP		Set Address Operation
	CCKO		Clears The Check Sum Output
	RCKO		Reads The Check Sum Output
	SCKO		Sets The Check Sum Output
	CCOP		Clear Continuous Data Output
	RCOP		Reads Continuous Data Output
	SCOP		Set Continuous Data Output
	CSOT		Clears The Scale Output
	RSOT		Reads The Scale Output
	SSOT		Sets The Scale Output
	CPAD		Sets The Delay Time Between Characters
	LPAD		Sets The Delay Time Between Lines
	LPWR		Places Unit Into Low Power Mode
	RCAL		Read Conductivity Calibration Data
	ROP		Read Operating Mode Parameters
	SB30		Communication Baud Rate Is 300
	SB12		Communication Baud Rate Is 1200
	SB96		Communication Baud Rate Is 9600
	SB19		Communication Baud Rate Is 19200
	SB38		Communication Baud Rate Is 38400
	SB57		Communication Baud Rate Is 57600
	SB15		Communication Baud Rate Is 15200
	S/N		Read Or Sets The Serial Number
	SFRM		Reads Or Sets The Output Format
	SSV		Enable Salinity And Sound Velocity
	VER		Read TS-NH Firmware Version Number



## Command Instructions Detailed:

**RAW**

### Usage

RAW

### Mode

RUN

### Description

Use this command to acquire all current A/D readings from the TS-NH.

### Returns

A string of 2 long values.

### Example

RAW&lt;CR&gt;&lt;LF&gt;

COND TEMP&lt;CR&gt;&lt;LF&gt;

Where:

COND – Conductivity reading

TEMP – Temperature reading

### See Also

SC, \*\*\*R

**MODE****Usage**

MODE

**Mode**

RUN, OPEN

**Description**

This command returns the mode the unit is currently in, either RUN or OPEN.

**Returns**

MODE&lt;CR&gt;&lt;LF&gt;

RUN&lt;CR&gt;&lt;LF&gt;

-OR-

OPEN&lt;CR&gt;&lt;LF&gt;

**PI****Usage**

PI

PI=xxx

**Mode**

RUN, OPEN

**Description**

This command sets or reads the pressure constant used to calculate sound velocity and salinity. This value is in dbars.

**Returns**

1. PI<CR><LF> (reads)  
PI=0.0<CR><LF>
2. PI=12<CR><LF> (sets)  
<CR><LF>

**SRATE****Usage**

SRATE

SRATE=x

**Mode**

RUN, OPEN

**Description**

This command reads or sets the scan rate for the unit. The scan rate is defined as "frames per second", where a "frame" is defined as a complete set of CTP data. Valid values for x are 1, 2, 3, 4 and 5.

**Returns**

The scan rate for the unit

**Example**

1. SRATE<CR><LF> (reads)  
SRATE=1 HZ<CR><LF>

2. SRATE=5 <CR><LF> (sets)  
<CR><LF>

\*\*\*O

## Usage

\*\*\*O

## Mode

RUN or CAL

## Description

This command enters the unit to the OPEN mode. Data collection is stopped. From the OPEN mode operational settings and calibration constants can be read and edited. The unit will return a message of "Open Mode" if data is requested by either a CR or LF command.

## Returns

<CR><LF>

S

## Usage

S

## Mode

RUN or CAL

## Description

This command must be an UPPER case Character. This command stops the continuous data output mode. The continuous data mode will not stop until the S command is issued.

## Returns

None

## See Also

SC, \*\*\*R

SC

**Usage**

SC

**Mode**

RUN or CAL

**Description**

This command sets the TS-NH in continuous data output mode. The TS-NH will report CT data at the Sampling Rate of the TS-NH. To stop the continuous data output mode use the 'S' command.

**Returns**

&lt;CR&gt;&lt;LF&gt;

**See Also**

S, \*\*\*R

\*\*\*C

**Usage**

\*\*\*C

**Mode**

OPEN

**Description**

This command enters the unit into the CAL mode. This mode allows the user to read reference data, internal temperature data, and the raw sensor data from the TS-NH.

**Returns**

&lt;CR&gt;&lt;LF&gt;

**\*\*\*R****Usage**

\*\*\*R

**Mode**

OPEN

**Description**

This command enters the unit into the RUN mode. It will only enter RUN mode if valid calibration factors are found for the unit. Valid data consists of non-zero values for A0n, A50n and A100n (see section 2 for calibration constant determination). After five seconds the unit will commence data writing if it is not interrupted by additional commands.

**Returns**

&lt;CR&gt;&lt;LF&gt;

**\*\*\*E****Usage**

\*\*\*E

**Mode**

OPEN

**Description**

This command is valid in OPEN mode. Upon entry of the command, all calibration constants and operational settings ARE written to EEPROM (saved). This is the only command that will update EEPROM data and must be used when data is to be saved. Note: You will overwrite any stored data so be sure your calibration constants are correct using the RCAL command prior to issuing this command.

**Returns**

&lt;CR&gt;&lt;LF&gt;

**ADR****Usage**

ADR

ADR=xy (The xy format is 00 to 99.)

**Mode**

OPEN

**Description**

This command reads or set the address for the unit. This address is the used when the unit is placed in address mode (RS485).

**Returns**

The address the unit is set to.

**Example**

Enter ADR <CR> or <LF>

The instrument displays the address of the instrument:

ADR=05 <CR> or <LF>

Enter ADR=67 <CR> or <LF> The instrument sets its address to 67 and outputs a <CR><LF>.

**See Also**

SAOP, CAOP, RAOP

## CAOP, RAOP, SAOP, #N

### Usage

CAOP  
RAOP  
SAOP  
#Nxy

### Mode

OPEN, RUN

ADR/CAOP/RAOP/SAOP commands only work in OPEN mode.

The #n/#N command can be entered in RUN or OPEN mode.

Continuous Output Mode (SCOP) cannot be used while in address operation mode.

Address Operation mode works ONLY with output format 0 (SFRM=0).

- When you try to enable the address operation mode using the SAOP command, if the SFRM command is set to a different format “ERROR! INCORRECT FORMAT FOR ADDRESS MODE” will display.
- If you try to change the SFRM setting after the Address Operation is enabled, you’ll get the error “ERROR, ADDRESSING ACTIVE”.

### Description

These commands set, clear, or read address operation. The intent of address operation is to enable the use of multiple instruments on the same serial connection. The address for each instrument must be unique and configured via the ADR command prior to connecting multiple instruments. Address operation will then enable a user to interact with a given instrument by sending the correct #Nxy string (where xy is the address number 0 to 99), executing commands, and then de-addressing the unit by sending a # character.



CAUTION. The #Nxy command is case sensitive and will behave slightly different depending on the mode.

#### While in **Run** Mode:

- No carriage return is needed after the # to “lock” or “de-address” the unit.
- After entering #Nxy or #nxy, the unit will immediately output a sample line. If you entered an uppercase “N”, the setting “sticks” and you can send additional commands or simply send another carriage return to get another sample.
- If you entered a lower-case “n”, the unit resumes ignoring commands. Entering #Nxy will make the unit respond to commands again.
- Addressing different instruments with the #Nxy command will automatically “de-address” all other connected instruments.

#### While in **Open** mode:

- Commands are not processed until a carriage return is sent. For example, the unit will not output the results of the ROP command if you enter #Nxy ROP. Therefore, you’ll need to enter a carriage return after the #Nxy command which makes the setting “take hold” and then send the ROP command next.
- The lowercase #nxy command doesn’t function in Open mode.



## SAOP

The SAOP command enables address operation. Once address operation is enabled, an instrument will respond to commands until a # character is sent. After this time, the instrument will ignore all commands until the instrument receives the string #Nxy (where xy is the instrument's address as set by the ADR command). After the instrument receives a valid address, it will respond to commands until another # character is sent. For example, if ADR=05, use #N05.

Note: The SAOP command must be followed by the \*\*\*E command to save the setting.

## CAOP

The CAOP command disables address operation.



CAUTION. The TS-NH unit must be addressed via the command #Nxy before address operation can be disabled via the CAOP command. Follow the example shown below for **Open** mode; otherwise if you send the CAOP command with more than one unit connected in the chain, all of the units will be talking over each other on the serial communication line.

Note: The CAOP command must be followed by the \*\*\*E command to save the setting.

## RAOP

The RAOP command reads the address operation.

Address op set, Adr = xy

Address op cleared, Adr = xy (where xy is the address number 0 to 99)

## Returns

The state of the address mode

## Examples

Using #nxy (where xy is the address number 0 to 99) while in **Run** mode will return a single sample without having to manually “de-address” the unit afterwards. For example, if you have several CTDs in a chain, while they're all running, you could just read each unit once by sending:

```
#n00
+0.3388, +21.8176, -0.0200, +00.1742, +1488.0041 (unit 00 returns this data)
#n01
+0.3388, +21.8178, -0.0201, +00.1743, +1488.0046 (unit 01 returns this data)
#n02
+0.3390, +21.8181, -0.0221, +00.1744, +1488.0057 (unit 02 returns this data)
...etc.
```

However, if you need to control/configure multiple units in **Open** mode, then you'll have to enter multiple commands (note you **MUST** use an uppercase “N”):

```
#N00 (address/unlock unit 00)
***O (change to open mode)
ROP (review configuration)
Etc. etc. to change something in the configuration
***R (to restart run mode)
# (to de-address the unit)
#N01 (address/unlock unit 01)
***O (change to open mode)
ROP (review configuration)
Etc. etc. to change something in the configuration
***R (to restart run mode)
# (to de-address the unit)
... And so on...
```

## See Also

ADR, SFRM

## CCKO, RCKO, SCKO

### Usage

CCKO  
RCKO  
SCKO

### Mode

OPEN

### Description

These commands set, clear, or read the Checksum data output mode. Checksum data output mode adds the checksum at the end of the line of data in RUN mode. The SCKO command sets the Checksum mode. The CCKO command clears the Checksum mode. The RCKO command reads the state of the Checksum mode.



NOTE. A “\*\*\*E” command must be issued after either command for changes to take effect upon next power up.

### Returns

The state of the Checksum data output mode

### Example

1. SCKO<CR><LF>  
Checksum output set <CR><LF>  
\*\*\*E<CR><LF>
2. CCKO<CR><LF>  
Checksum output cleared <CR><LF>
3. RSOT <CR><LF>  
Checksum output set <CR><LF>  
-OR-  
Checksum output cleared <CR><LF>

## CCOP, RCOP, SCOP

### Usage

CCOP  
RCOP  
SCOP

### Mode

OPEN

### Description

These commands set, clear, and read continuous data output after power up. The SCOP command sets continuous data output on power up. The CCOP command clears the continuous data on power up. A "\*\*\*E" command must be issued after either command for changes to take effect upon next power up. RCOP reads the state of continuous data.

### Returns

The state of continuous data output on power up.

### Example

1. SCOP<CR><LF>  
Continuous set<CR><LF>  
\*\*\*E<CR><LF>
2. CCOP<CR><LF>  
Continuous cleared<CR><LF>  
\*\*\*E<CR><LF>
3. RCOP<CR><LF>  
Continuous set<CR><LF>  
-OR-  
Continuous cleared<CR><LF>

## CSOT, RSOT, SSOT

### Usage

CSOT  
RSOT  
SSOT

### Mode

OPEN

### Description

These commands set, clear, and read the Scaled units mode. The SSOT command sets the data format to be reported in Scaled units. The SSOT command overrides the SFRM command. The CSOT command sets the data format to be reported in engineering units. A “\*\*\*E” command needs to be issued after either one of these commands for changes to have an effect on next power up. The RSOT command returns the state of the output, either on or off.

### Returns

The state of the Scale units in run mode

### Example

1. SSOT<CR><LF>  
Scaled output set <CR><LF>  
\*\*\*E<CR><LF>
2. CSOT<CR><LF>  
Scaled output cleared <CR><LF>
3. RSOT <CR><LF>  
Scaled output set <CR><LF>  
-OR-  
Scaled output cleared <CR><LF>

### See Also

SFRM

**CPAD****Usage**

CPAD

CPAD=*x*

**Mode**

OPEN

**Description**

This command sets or reads the delay between the characters in the serial communications.

**Returns**

The delay in milliseconds

**Example**

1. CPAD<CR><LF>  
CPAD=2<CR><LF>
2. CPAD=1<CR><LF>  
<CR><LF>

## Usage

LPAD

LPAD=x

## Mode

OPEN

## Description

This command sets or reads the delay between the lines in the serial communications.

## Returns

The delay in milliseconds

## Example

1. LPAD<CR><LF>            (reads)  
   LPAD=2<CR><LF>

2. LPAD=1<CR><LF>        (sets)  
   <CR><LF>

**LPWR****Usage**

LPWR

**Mode**

OPEN

**Description**

This command sets the unit into low power mode. This has minimal current draw and allows the user to save battery life. No accumulation of data occurs in this mode.

**Returns**

The low power status

**Example**

1. LPWR<CR><LF>  
Entering Low Power Mode...

## Usage

RCAL READ CALIBRATION DATA

## Mode

OPEN

## Description

This command reads all calibration data for a single primary channel from the TS-NH. Note these values are the values held in volatile memory until the user issues the "E" command at which time they are written into EEPROM (non-volatile memory). The user cannot change the S/N or version numbers.

## Returns

As Specified

## Example

```
RCAL<CR>
S/N=1416
Firmware Version 1.1
CDATE=27APR04
A1=-1.509000E-01
B1=8.795188E-05
ALPHA=-2.137000E-06
BETA=1.169000E-06
T0=25.000000
P0=0.0
KFAC=1.360000
A2=35.747410
B2=-4.956421E-01
C2=6.590000E-04
D2=-1.721404E-05
E2=1.500457E-07
F2=-4.044866E-09
G2=6.753171E-11
H2=-7.074421E-13
I2=2.393916E-15
```



## Usage

ROP

## Mode

OPEN

## Description

This command displays the current state of the run-time configuration.

## Returns

Serial Number  
State of the Continuous mode of data reporting  
State of the Address mode of data reporting  
State of the Scaled mode of data reporting  
State of the Checksum mode of data reporting  
Arate  
Scan rate  
The filter  
The Lag  
The pressure constant

## Example

### 1. ROP<CR><LF>

```
S/N=1415  
Continuous cleared  
Address op cleared  
Scale output cleared  
Checksum output cleared  
Arate = 9  
Srate = 1 Hz  
N=3  
Lag=7.500000E-01  
PI=0.0<CR><LF>
```

## SB30, SB12, SB96, SB19, SB38, SB57, SB15

### Usage

SB30	(Baud Rate of 300)
SB12	(Baud Rate of 1200)
SB96	(Baud Rate of 9600)
SB19	(Baud Rate of 19200)
SB38	(Baud Rate of 38400)
SB57	(Baud Rate of 57600)
SB15	(Baud Rate of 115200)

### Mode

OPEN

### Description

These commands will change the communication baud rate of the TS-NH. If one of these commands are issued the user must change the serial baud rate of the host device to continue communications with the TS-NH.

### Returns

<CR><LF>



**NOTE.** The TS-NH changes the serial baud rate baud after the <CR><LF> character leave the communication port.

**Usage**

S/N

**Mode**

OPEN

**Description**

This command outputs the serial number of the TS-NH. Every TS-NH shipped from TRDI contains a unique 4 digit serial number.

**Returns**

XXXX<CR><LF>

**Example**

S/N<CR><LF>  
1415< CR ><LF>

## Usage

SFRM <CR> or <LF> SFRM=n <CR> or LF>

## Operating Modes

Open

## Description

The SFRM command allows you to select the output format of the data from a list of available formats, including standard TRDI format. The output selections are available for special customer requirements and can be customized in accordance with customer needs.



**NOTE.** The SFRM command must be followed by the \*\*\*E command to save the setting.

## Returns

See Examples below.

## Examples

Enter SFRM <CR> or <LF> The instrument displays the current output format:

```
SFMR=1: 000452 23.24 45.3 35.17 12.3
```

Enter SFRM=1 <CR> or <LF> The instrument sets the new output format followed by a <CF<LF>.

To enable the Valeport output format:

1. First put the instrument into open mode:

```
***O
```

2. Configure the CTD-N to output the Valeport string by sending:

```
SFRM=8
```

3. Then set the CTD-N to run mode and continuous output:

```
***R
```

```
SC
```

## Format Specifications

### SFRM=0

```
04-01-16, 08:32:19, +0.3432, +22.1575, +0.0047, +00.1753, +1488.9935, +21.48
DATE, TIME, CC.CCCC, TT.TTTT, PPPP.PPPP, SS.SSSS, VVVV.VVVV, vv.vv
```

### SFRM=1

```
000009 22.15 0.3 0.18 12.3
hhmmss TT.TT CC.CC SS.SS 12.3
```

### SFRM=2

```
000045 22.14 0.3 0.18 N/A 0.00 12.3
hhmmss TT.TT CC.CC SS.SS N/A PP.PP 12.3
```

### SFRM=3

0.343, 22.139, 0.0003, 0.1751, 1488.9410  
 CC.CCC, TT.TTT, PP.PPPP, SS.SSSS, VVVV.VVVV

**SFRM=4**

000255 22.14 0.3 0.18 12.3 00000 00000 00000 00000 0.0  
 hhmms TT.TT CC.CC SS.SS 12.3 optData0 optData1 optData2 optData3 BioSpherical

**SFRM=5**

000509 22.13 0.3 0.18 N/A -0.00 12.3 00000 00000 00000 00000 0.0  
 hhmms TT.TT CC.CC SS.SS N/A PP.PP 12.3 optData0 optData1 optData2 optData3 BioSpherical

**SFRM=6**

000721 22.13 0.3 0.18 21.52 0.0000 0.0000 0.0000 0.0000 0.000 0.000 0.000  
 hhmms TT.TT CC.CC SS.SS vv.vv optData0 optData1 optData2 optData3 Compass Pitch Roll

**SFRM=7**

\$BFCTD,+0.1525,22.1323,+0.0046,10:26:44 04-01-16,+03.0161,+1492.7867,\*66  
 \$BFCTD, CC.CCCC, TT.TTTT, PP.PPPP, hh:mm:ss mm-dd-yy, SS.SSSSS, VVVV.VVVV, \*ck

**SFRM=8**

+VVV.VVVV \t M/SEC \t +PP.PPPP \t DBAR \t +TT.TTTT \t C \t +CC.CCCC \t MS/CM \t  
 +SS.SSSS \t PSU\r\n

Where:

- VVVV.VVVV = Sound Velocity
- PP.PPPP = Pressure
- TT.TTTT = Temperature
- CC.CCCC = Conductivity
- SS.SSSS = Salinity
- \t = tab (0x09 binary, 8-bits)
- \r = return (0x0d binary, 8-bits)
- \n = line feed (0x0A binary, 8-bits)

**Sample Output**

```

***O
SFRM=8
***R
SC
+1492.7867          M/SEC +0.0046   DBAR   +23.5327   C   +0.1525
                   MS/CM +00.0774   PSU
+1492.7819          M/SEC +0.0144   DBAR   +23.5310   C   +0.1524
                   MS/CM +00.0773   PSU
+1492.7777          M/SEC +0.0236   DBAR   +23.5294   C   +0.1524
                   MS/CM +00.0773   PSU
+1492.7734          M/SEC +0.0309   DBAR   +23.5278   C   +0.1523
                   MS/CM +00.0773   PSU
+1492.7706          M/SEC +0.0237   DBAR   +23.5268   C   +0.1525
                   MS/CM +00.0774   PSU
+1492.7650          M/SEC +0.0194   DBAR   +23.5249   C   +0.1522
                   MS/CM +00.0773   PSU
S
  
```

**See Also**

\*\*\*E, CAOP, RAOP, SAOP

## Usage

SSV  
SSV=ON  
SSV=OFF

## Mode

OPEN

## Description

These commands are used to enable or disable the salinity and sound velocity channels. When SSV=off, salinity and sound velocity are not displayed. When SSV=on, salinity and sound velocity are calculated and displayed in RUN MODE.

## Returns

The state of sound velocity and salinity for run mode

## Example

1. SSV=ON<CR><LF> (turns on sound velocity and salinity)  
<CR><LF>
2. SSV=OFF<CR><LF> (turns off sound velocity and salinity)  
<CR><LF>
3. SSV  
SAV and SV is ON<CR><LF>  
-OR-  
SAV and SV is OFF<CR><LF>

**VER****Usage**

VER

**Mode**

OPEN

**Description**

This command outputs the Firmware Version of the TS-NH. This determines the revision level of the firmware in the TS-NH.

**Returns**

VX.X&lt; CR &gt;&lt;LF&gt;

**Example**

```
VER<CR>  
V1.3< CR ><LF>
```

**Carriage-Return or Linefeed****Usage**

The single character Carriage-Return, character (13d) or (0Dh) or Ctrl-M. The single character Linefeed, character (10d) or (0Ah) or Ctrl-J.

**Mode**

CAL or OPEN

**Description**

Sending a carriage-return or linefeed character alone is a request for DATA. The TS-NH will respond with the current scan of data in scaled engineering format.

**Returns**

MODE DEPENDANT

**See Also**

SC, S

## Error Messages

For any invalid command, the TS-NH will respond with the "bell" character and either "Bad Command" or an error message depicting the nature of the error. A command is invalid if it is not recognized or if it is incomplete or parts are incorrect. Also where noted, some commands are only valid when the TS-NH is in a specific mode and are invalid in the other modes.

<b>Error</b>	<b>Reason</b>
"Bad Command"	Unrecognized command, generic in all operational modes. Re-enter command after checking validity of command in the present operational mode of the instrument. Note, most commands are only functional while the instrument is in the OPEN mode.
"EPROM Failure"	The checksum calculation for the TS-NH calibration coefficients and operational settings was lost due to an EEPROM failure.



---

# APPENDIX A: Warranty, Liability and RMA Return Procedure

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## Teledyne RD Instruments Limited Warranty

Teledyne RD Instruments (TRDI) guarantees its products to be free from defects in materials and workmanship for a period of one year from the date of shipment. In the event a product malfunctions during this period, TRDI's obligation is limited to the repair or replacement, at TRDI's option, of any product returned to the TRDI factory. Products found defective should be returned to the factory freight prepaid and carefully packed, as the customer will be responsible for any damage during shipment.

Repairs or replacements, parts, labor, and return shipment under this warranty will be at no cost to the customer. This warranty is void if, in TRDI's opinion, the product has been damaged by accident or mishandled, altered, or repaired by the customer, where such treatment has affected its performance or reliability. In the event of such mishandling, all costs for repair and return freight will be charged to the customer. All products supplied by TRDI that are designed for use under hydrostatic loading have been certified by actual pressure testing prior to shipment. Any damage that occurs as a direct result of flooding is NOT covered by this warranty.

If a product is returned for warranty repair and no defect is found, the customer will be charged a diagnostic fee plus all shipping costs. Incidental or consequential damages or costs incurred as a result of a product's malfunction are not the responsibility of TRDI.

Equipment not manufactured by TRDI is supported only to the extent of the original equipment manufacturers (OEM) original warranties. All OEM sensors that utilize electrodes (oxygen cartridges, pH, ORP, etc.) are warranted at the time of shipment, and shall perform upon initial installation within stated specifications. If the product proves to be defective within the OEM's warranty, TRDI will replace the product or defective part with a similar model, product or part, but only to the extent that the OEM warrants.

All returned products must be accompanied by a Returned Material Authorization (RMA) number issued by TRDI. Shipments without an RMA number will not be accepted.

## Liability

TRDI shall not be liable for incidental or consequential damages, injuries, or losses as a result of the installation, testing, operation, or servicing of TRDI products.

# Returning CTDs to TRDI for Service

When shipping the system to TRDI from either inside or outside the United States, the following instructions will help ensure the CTD arrives with the minimum possible delay. Any deviation from these instructions increases the potential for delay.

- All shipments must be accompanied by two copies of your commercial invoice showing value of material and any reason for return.
- Whenever possible, please send copies of the original export shipping documents with the consignment.
- If the equipment is property of TRDI, please insure for full value.
- If the value is in excess of \$1,000.000, the following shippers oath must be sent with the invoices. (This can be typed on the invoice or on a separate letterhead).

“I, \_\_\_\_\_, declare that the articles herein specified are, the growth, produce, or manufacture of the United States; that they were exported from the United States; from the Port of \_\_\_\_\_, on or about \_\_\_\_\_; that they are returned without having been advanced in value or improved in condition by any process of manufacture or any other means, that no drawback, bounty, or allowance has been paid or admitted thereof.

Signed \_\_\_\_\_”

## Domestic Shipments

### Step 1 - Request a Return Material Authorization

To obtain a Return Material Authorization (RMA) number and shipping instructions for the return of your instrument, do one of the following:

- Open the RMA using the web link: <http://adcp.com/support/sendADCP.aspx>
- Contact Customer Service Administration at [rdicsadmin@teledyne.com](mailto:rdicsadmin@teledyne.com)
- Call +1 (858) 842-2700

When requesting a RMA number, please give us the following information:

- What is being shipped (include the serial number)
- When you plan to send the shipment
- What issue(s) need to be corrected
- Name of the Field Service Engineer that knows about the issue
- When you need the instrument returned

TRDI's Customer Service will then respond with the RMA number for the shipment. Please include this number on all packages and correspondence.

**Step 2 – Provide a MSDS as necessary**

Please provide a Material Safety Data Sheet (MSDS) if the system/transducer is painted with antifouling paint.

**Step 3 - Ship via air freight, prepaid**

*Urgent Shipments* should be shipped direct to TRDI via overnight or priority air services. Do not send urgent airfreight as part of a consolidated shipment. If you ship consolidated, it will cost less, but may lose up to three days in transit time.

*Non-urgent shipments* may be shipped as part of a consolidated cargo shipment to save money. In addition, some truck lines may offer equivalent delivery service at a lower cost, depending on the distance to San Diego.

Mark the Package(s)

**To: Teledyne RD Instruments, Inc. (RMA Number)  
14020 Stowe Drive  
Poway, California 92064**

**Airport of Destination = San Diego  
Notify Paxton, Shreve, and Hayes  
Phone: +1 (619) 232-8941  
Fax: +1 (619) 232-8976**

**Step 4 - Urgent shipments**

Send the following information by fax or telephone to TRDI.

**Attention: Customer Service Administration**

**Fax: +1 (858) 842-2822**

**Phone: +1 (858) 842-2700**

- Detailed descriptions of what you are shipping (number of packages, sizes, weights, and contents).
- The name of the freight carrier
- Master Air bill number
- Carrier route and flight numbers for all flights the package will take

## International Shipments

**Step 1 - Request a Return Material Authorization**

To obtain a Return Material Authorization (RMA) number and shipping instructions for the return of your instrument, do one of the following:

- Open the RMA using the web link: <http://adcp.com/support/sendADCP.aspx>
- Contact Customer Service Administration at [rdiefs@teledyne.com](mailto:rdiefs@teledyne.com)
- Call +33(0) 492-110-930

When requesting a RMA number, please give us the following information.

- What is being shipped (include the serial number)
- When you plan to send the shipment
- What issue(s) need to be corrected
- Name of the Field Service Engineer that knows about the issue

- When you need the instrument returned

TRDI's Customer Service will then respond with the RMA number for the shipment. Please include this number on all packages and correspondence.

**Step 2 – Provide a MSDS as necessary**

Please provide a Material Safety Data Sheet (MSDS) if the system/transducer is painted with antifouling paint.

**Step 3 - Ship Via Air Freight, Prepaid**

*Urgent Shipments* should be shipped direct to TRDI via overnight or priority air services. Do not send urgent airfreight as part of a consolidated shipment. If you ship consolidated, it will cost less, but may lose up to three days in transit time.

*Non-urgent shipments* may be shipped as part of a consolidated cargo shipment to save money.

Mark the package(s) as follows:

**To: Teledyne RD Instruments, Inc. (RMA Number)  
2A Les Nertieres  
5 Avenue Hector Pintus  
06610 La Gaude, France**

**Step 4 - Include Proper Customs Documentation**

The Customs statement must be completed. It should be accurate and truthfully contain the following information.

- Contents of the shipment
- Value
- Purpose of shipment (example: "American made goods returned for repair")
- Any discrepancy or inaccuracy in the Customs statement could cause the shipment to be delayed in Customs.

**Step 4 - Send the Following Information by Fax or Telephone to TRDI**

**Attention: Sales Administration  
Phone: +33(0) 492-110-930  
Fax: +33(0) 492-110-931**

- Detailed descriptions of what you are shipping (number of packages, sizes, weights, and contents).
- The name of the freight carrier
- Master Air bill number
- Carrier route and flight numbers for all flights the package will take